Discussion of “evaluation of an innovative composite railway 1 sleeper for a narrow-gauge track under static load”

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DOI:
10.1061/(ASCE)CC.1943-5614.0000915

Discussion of "Evaluation of an Innovative Composite Railway Sleeper for a Narrow-Gauge Track under Static Load" by Wahid Ferdous; Allan Manalo; Gerard Van Erp; Thiru Aravinthan.

April 2018, Vol 22 No 2, 04017050

DOI: 10.1061/(ASCE)CC.1943-5614.0000833

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The development of novel material technologies for railway tracks is welcome indeed. The discusser read with interest the paper, which was well written by the authors. It is appreciated that the authors concluded that the study has limitations, and that further research is needed. Thus, the discusser strongly recommends that the authors continue to perform field measurements on the composite sleepers that are currently installed on the tracks. This recommendation stems from the fact that:

- The authors focused solely on the quasi-static behavior. The 'design' rail seat load was determined using a combination of American code and empirical algorithms. As the design method for composite sleepers has not been standardized yet (Silva et al., 2017), the discusser believes that this 'design' load is based on allowable stresses. Therefore, it is imperative that material reduction factors be identified based on the data collected through field measurements (You et al., 2017). This data would later aid the railway owner

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or authority to verify the cost-effectiveness and safety margin of the composite sleepers, as shown in Figure 1. This allowable stress design concept determines the maximum strength of constituent materials, which then cannot be exceeded in the component. Safety and serviceability aspects such as brittle fracture, bursting, fatigue failure and allowable deflections are taken into account in this design method by the determination of safety factor values. The cost-effectiveness can then be evaluated using reliability indices (Kaewunruen and Remennikov, 2009) whether the component is either optimally, overly or under-designed.

- The dynamic service load factor (or impact factor) of 1.5 and axle load distribution factor of 0.48 were used in the initial design. These values are slightly different from those presented in other reports with similar track moduli, such as in Leong and Murray (2008). In addition, by inserting a composite sleeper sideways over an existing old foundation, the track modulus could significantly deviate from the originally assumed value of 30 MPa. Therefore, it is important to ensure that such changes due to maintenance operations do not result in longer-term track problems as reported in the past (Kaewunruen et al., 2018).
- It is critical to note that narrow-gauge sleepers tend to be damaged from center-binding. Center-binding occurs at the midspan of short sleepers subject to hogging moments, especially as the ballast densifies and deteriorates over time under dynamic loads (Remennikov and Kaewunruen, 2008; You et al., 2018). In many instances, the midspan cross section of a sleeper becomes the most critical section for design, as it is often the case in narrow-gauge sleepers

(Standards Australia, 2012). A better insight into this behavior would assist track engineers with devising suitable plans for track inspection.

The discusser hopes that the field experience and practical notes shared in this discussion are useful and encourage the authors to extend their future research to field measurements.

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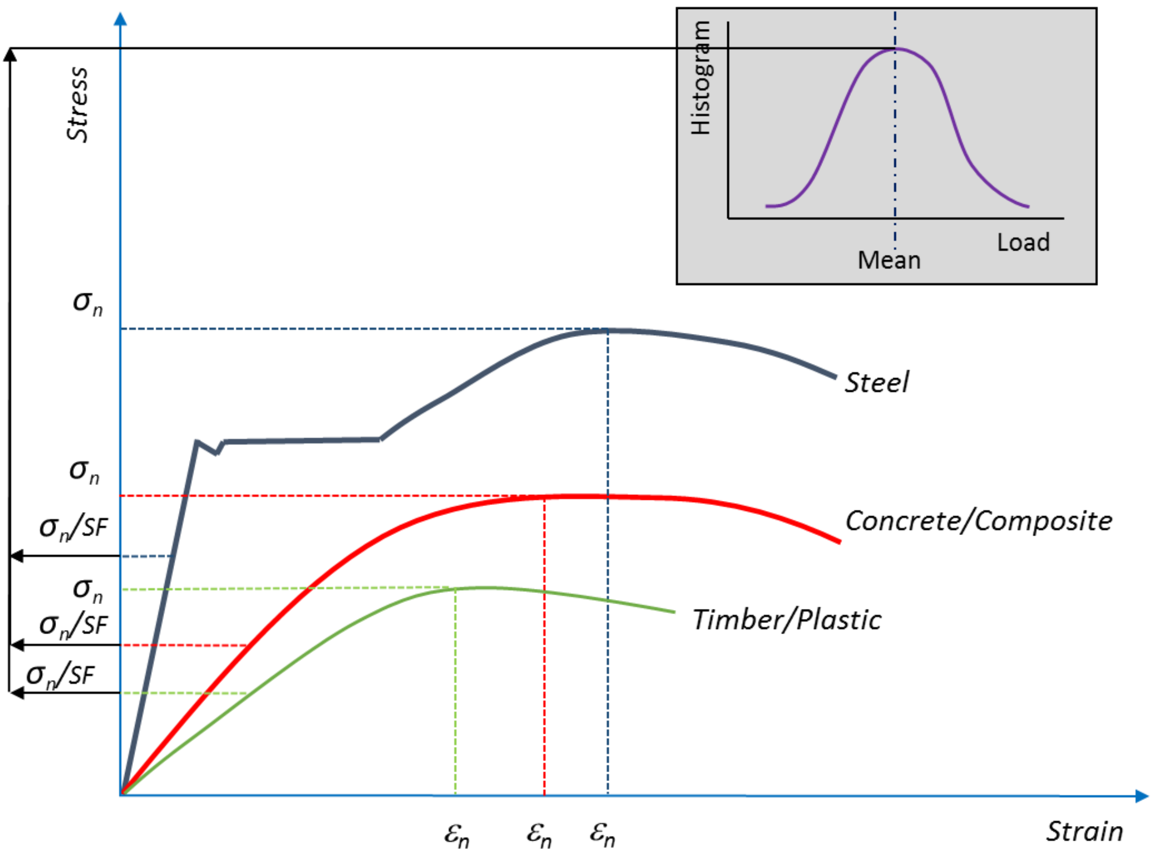

Figure 1. Allowable stress design method of each material (SF is safety factor)